Chemical & Engineering NEWS

A Key Chemicals Review Page

Fiber monomers thr... through rough year

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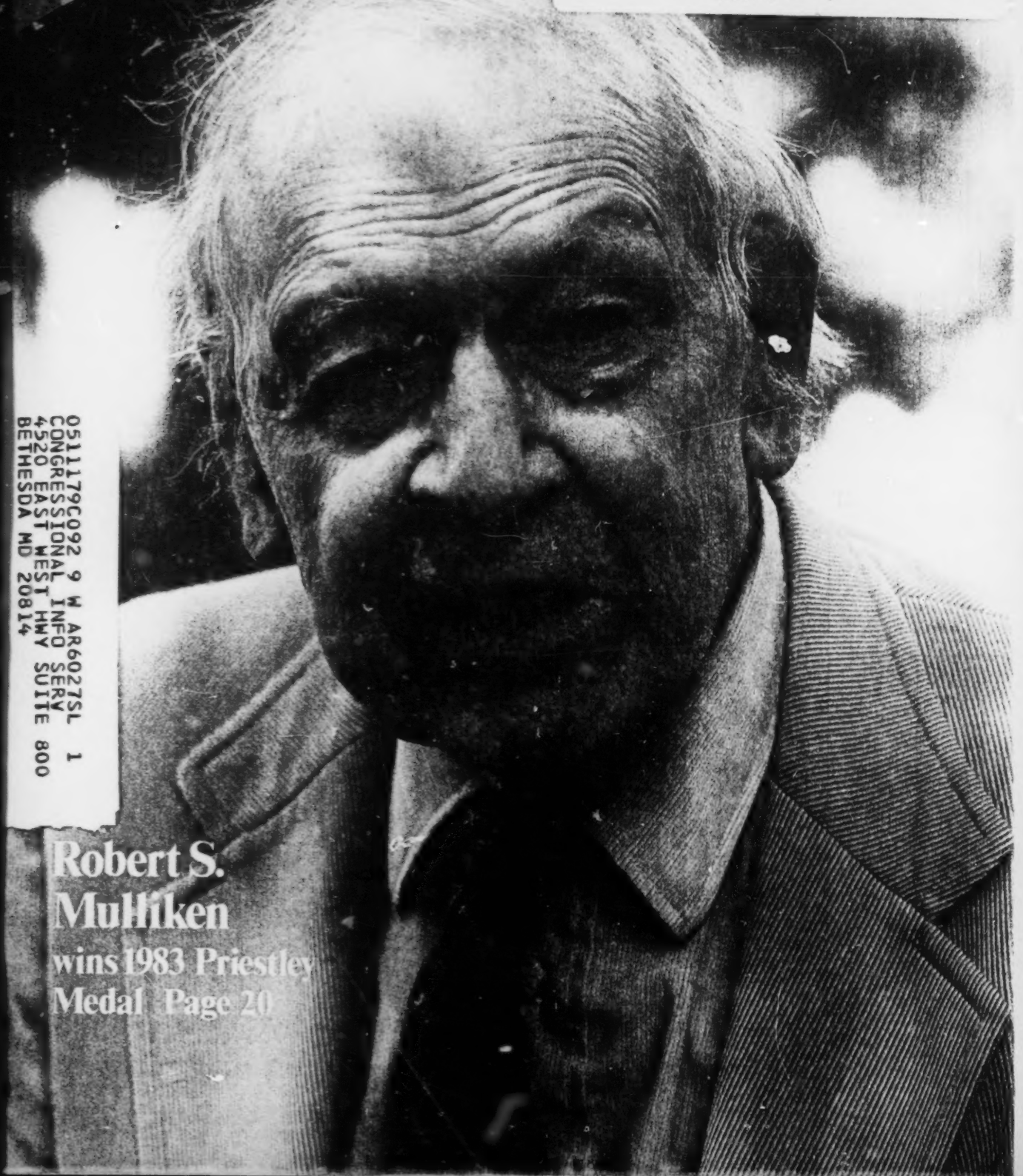

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Robert S. Mulliken

wins 1983 Priestley Medal Page 20

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Priestley Medal

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Fiber raw materials follow fibers downturn

Intermediates for polyester and nylon—DMT/PTA, ethylene oxide, and cyclohexane—lose volume and value in recession

Bruce F. Greek
C&EN, Houston

Bare legs, old clothes, and expensive mortgages are the plague of synthetic fibers and, in turn, the chemicals that go into them. Inexpensive fashions and a recession-torpedoed housing market will make 1982 another down year for major organic chemicals used primarily in synthetic fibers.

The prospects for 1982 and beyond for dimethyl terephthalate and purified terephthalic acid (DMT/PTA), ethylene oxide, and cyclohexane are bleak. Combined U.S. production will decline this year and selling prices remain low in spite of efforts to raise them, leaving total value and profits in shambles.

This outlook relates directly to a continuing shakeout in the synthetic fibers business. A year ago, it was viewed generally that fibers had completed a heavy round of plant shutdowns and company exits, leaving capacity quite lean and financial prospects bright in the next economic expansion. Now, a year later, fashion and the world economy have the shakeout going again.

A case in point is Celanese's decision to shut down 200 million lb per year of capacity for polyester filament beginning this August (C&EN, May 31, page 7). Although this capacity is relatively small in the total, it does mean some decline in demand for polyester ingredients, DMT/PTA and ethylene glycol derived from ethylene oxide.

Similarly, Du Pont's plans to reduce its nylon fiber production will reduce demand for raw material cyclohexane. Merchant sales of cyclohexane to Du Pont will decline further next year when the company completes it own unit to make part of its cyclohexane requirements.

Key Chemicals

The continuing shakeout in fiber capacity leads to a serious question of whether sufficient capacity remains to meet future demand. Not everyone agrees on this point, with some expecting an upsurge in demand to cause shortages because of limited capacity. Others, however, expect that capacity could expand quickly to meet demand.

Although there might be a fiber capacity problem, few in the industry anticipate a capacity problem for fiber raw materials. Currently, operating rates for plants making DMT/PTA, ethylene oxide, and cyclohexane are quite low as inventories are worked off. Some pickup in operating rates is expected later in the second half of 1982, which would push the average rate for the year higher than it has been recently.

The worst prospects seem to be for cyclohexane, which may have an average 1982 operating rate of less than 50% of nameplate capacity. This means, of course, that much capacity actually will be shut down during 1982. Longer-term prospects are not very good either, with average annual production gains for the rest of the 1980s at about 2%.

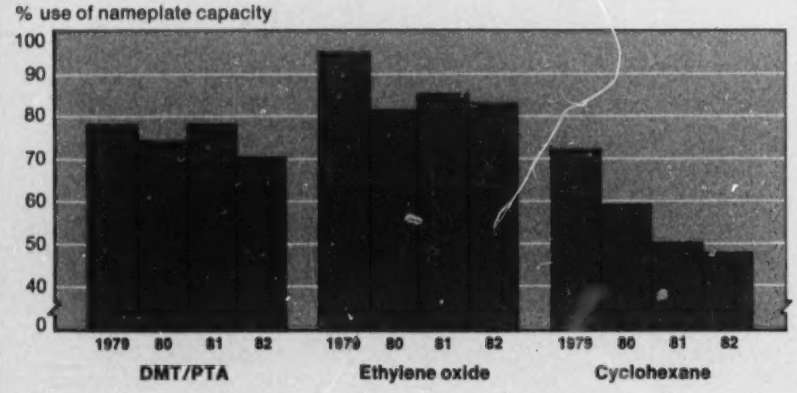
The longer-term outlook for polyester materials is a little better but not much, because their end uses have low growth rates in all but bottles and a few other small nonfiber uses. Ethylene oxide's other major use, antifreeze via the glycol, will at best about match fiber growth because of changes in automobiles and driving habits. Since operating rates for DMT/PTA and ethylene oxide are expected to be 70 to 80% in 1982, with long-term growth rates of 3 to 4%, capacity for these materials could begin to fall short of demand in the second half of the 1980s.

But far more important to producers this year is the anemic state of profit. Combined production will be down, perhaps as much as 600 million lb, or 5%, from 1981 output of 12.5 billion lb. Total value, because of selling price declines, could be down $1.5 billion, or 30% from the early estimate of $5.1 billion for 1981.

Partially offsetting the large value decline is a decline in most raw materials costs. Ethylene's price, for example, has tumbled from about 25 cents a lb to 18 cents, or nearly 30%. Benzene, the major-cost item in cyclohexane raw materials, has declined more than 15%.

Whether selling prices of these intermediates will decline further as such raw materials' prices decline is a matter of argument. The aromatics seem less likely to decline. Ethylene, too, could be at a bottom as supplies of low-cost raw material ethane start to expire.

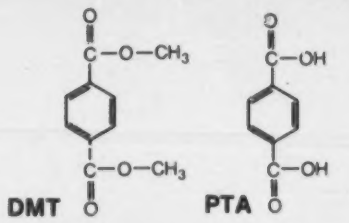
Plant capacity use drops this year for all three



Sources: Industry and C&EN estimates; International Trade Commission

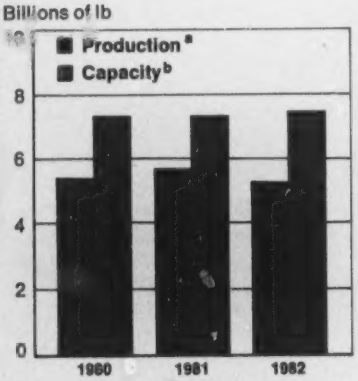
Key Chemicals

DMT/PTA



- ***Demand well down***
- ***Capacity level***
- ***Prices on hold***

PRODUCTION/CAPACITY



a Total for both DMT and PTA. b First quarter.

HOW MADE

Oxidation of p-xylene and concurrent esterification to make DMT; oxidation of p-xylene to make PTA

MAJOR DERIVATIVES (U.S.)

Polyethylene terephthalate 95%, polybutylene terephthalate 5%

MAJOR END USES (U.S.)

Polyester fibers 80%, films 10%, bottles, other fabricated forms 10%

FOREIGN TRADE

Exports—300 million lb, imports—negligible

PRICES

List prices about 35 cents per lb for DMT and 38 cents per lb for PTA

COMMERCIAL VALUE

$1.75 billion for production, 1982

U.S. producers of dimethyl terephthalate (DMT) and purified terephthalic acid (PTA) are playing recession poker in 1982 without the ace up their sleeve that let them score surprisingly high in 1981. The odds are against them, even though they might outplay producers of many other organic chemicals.

Luck has been oddly fickle for DMT and PTA over the past several years. Ups and downs seem to alternate no matter what the general economy does. For example, producers this year face an outcome similar to 1980 instead of 1981. Total production of these two derivatives of *p*-xylene could drop this year to as low as 5.2 billion lb. In 1981, despite the sharp U.S. recession beginning in late summer, DMT/PTA output rebounded to 5.7 billion lb because of an export boomlet. This rebound followed a recessionary decline to 5.4 billion lb in 1980 after production peaked at 5.7 billion lb in 1979. If this choppy pattern holds, producers could look toward another gain in 1983.

(These data are industry estimates, which run 10 to 20% below official government figures. Government statistics are considered too high because of double counting of DMT and PTA.)

Because of four years (through 1982) of no new growth in production for DMT and PTA, earlier forecasts for these materials obviously look bad—as do forecasts for many other major organic chemicals. Some of these earlier forecasts included predictions that additional capacity would be coming on stream from now through 1984. Undoubtedly, if demand had kept going as it had in the 1970s, more capacity would have been needed by now.

Fortunately, cool heads prevailed, and no major capacity has been added in the past two years. None is being built now except for minor gains that are really by-products of efficiency campaigns.

This lack of added capacity probably will allow producers to operate nameplate capacity of 7.4 billion lb per year at about an average rate of 70% during 1982. This will be down from an estimated 78% in 1981. Although neither of these rates is a real money-maker for producers, they are fairly good these days for organic chemicals.

The 1981 operating rate was spurred by larger-than-expected exports of derivative polyester, both as fiber and the precursor chips. Exports of DMT and PTA themselves probably were down in 1981 from more than 400 million lb in 1980. At least another 600 million lb (in terms of DMT/PTA) was exported in the form of fibers. Polyester film and molding resins added a small amount.

This year, mainly because of economic changes in various countries and startup of local plants producing DMT, PTA, and polyesters in fabricated forms, U.S. exports are expected to decline substantially. The variables here are many. Long-term operability of the new foreign plants could influence U.S. exports either way: Greater than expected success could mean lower U.S. exports, but startup troubles could keep exports high. The net effect on DMT and PTA production in the U.S. could be between 200 million and 600 million lb.

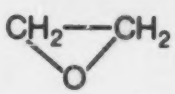
Polyesters will have a diverse market situation in the U.S., too. The bright spot will be the much-talked-about bottle resins. The darker side will be the fibers business.

Bottle resins continue in strong development along with many auxiliaries, especially bottle-making machines. Capacity to make bottle resins seems sufficient, owned mainly by polyester producers. Boosting machines' bottle production rates is now the main challenge to reducing costs in making small-sized polyester bottles.

The fiber side of polyester will not match 1981 demand in 1982—for many reasons. One is that the price of competing cotton has declined roughly a third from its peak, even though cotton futures currently are rebounding. This makes cotton relatively more attractive in blends with polyester. The lower cotton price also tends to make all-cotton garments cheaper to produce, allowing firms more promotional money to push sales. Another factor is a continued shift toward informal clothes, which has cut into sales of polyester blends with wool. U.S. consumption of DMT and PTA as a polyester fiber could be off 100 million lb in 1982.

On balance, the 1982 outlook for DMT and PTA in the U.S. calls for a rough balance between a gain in bottles and other nonfiber uses and a decline in fibers. The real blow is expected in derivatives exports.

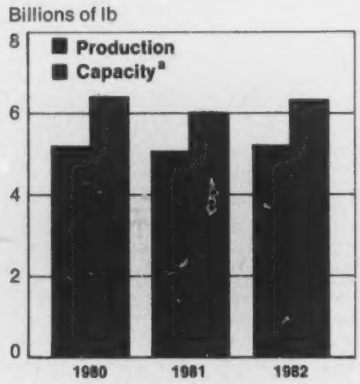
Key Chemicals



Ethylene Oxide

- ***Demand flat***
- ***Capacity back up***
- ***Prices badly discounted***

PRODUCTION/CAPACITY



[a] First quarter. **Note:** Capacity figures exclude units indefinitely shut down, about 0.5 billion lb in 1982.

HOW MADE

Vapor-phase oxidation of ethylene with oxygen or air

MAJOR DERIVATIVES (U.S.)

Ethylene glycol 60%, ethoxylates 10%, glycol ethers 10%

MAJOR END USES (U.S.)

Polyester fibers and films 30%, antifreeze 25%, surfactants 10%

FOREIGN TRADE

Exports—small, decreasing; imports—small, possibly increasing

PRICES

List prices up to 45 cents a lb, with discounts up to a third of list

COMMERCIAL VALUE

$1.5 billion for production, 1982

Like a ship traveling through a storm on gyroscopic control, ethylene oxide is displaying notable stability for an organic chemical in the current severe recession. Production and plant capacity aren't growing, but they aren't in danger of capsizing either as are a great many other products. And capacity use in operating units has stayed decently high. True, ethylene oxide's merchant price is in shambles, but its open-market sales are small.

This doesn't mean, however, that ethylene oxide is steaming through a great year. To producers, 1982 marks the third straight year on a plateau about 9% below the product's 1979 record production of 5.7 billion lb. The range of volume estimated for 1982 is remarkably small. Analysts say that if the economy does a modest turnaround in the second half, aiding automobile sales and housing, production of ethylene oxide could reach 5.2 billion lb. If there is no such bounce, production likely will run 5 billion lb or a bit less.

Since production topped out in 1979, it has fluctuated around 5.2 billion lb. Most industry sources don't expect to see the 1979 mark exceeded until 1983, if then. But production won't decrease much either, because ethylene oxide has staying power in the event of a renewed downturn.

Assuming production stays in the expected range in 1982, ethylene oxide plants will run at an average rate of about 80% of operable nameplate capacity for the year. Capacity as the year opened was about 6.3 billion lb.

This capacity figure has become an elusive item in recent years. Some capacity, nearly 1 billion lb out of a nominal total of 6.8 billion lb, has been shut down so long that few people expect it to run again. Other capacity continues to grow without plant additions because of process technology improvements, especially catalyst changes. To complicate things a bit more, some of the shutdown capacity, possibly 300 million lb per year, will materialize again as PPG Industries, in cooperation with Du Pont, moves a unit from Puerto Rico to Beaumont, Tex. So next year, thanks to debottlenecking, technology improvements, and startups, capacity probably will increase 300 million lb, or about 5%, to 6.6 billion lb.

Ethylene oxide has one dominant use, ethylene glycol, which in turn has two major outlets in polyesters and antifreeze. Ethylene glycol takes 60% of ethylene oxide production, with much of the conversion done in units right next to oxide units. All ethylene glycol producers make ethylene oxide. Many appear to have enough nameplate capacity in excess of glycol needs to make some sales in the merchant (open) market.

Of the glycol's two major markets, polyester continues to get the nod as the main future growth outlet for ethylene oxide. Even so, polyester fibers aren't doing well. They currently have a bit more competition than usual, since cotton prices, even after a slight rebound, are relatively low. This induces textile producers to increase the cotton content of polyester-cotton blends. Somewhat offsetting the cotton price have been low prices for polyester's raw materials, ethylene and *p*-xylene, as a result of the slump in crude oil prices.

Polyester fibers have another problem in 1982 because of a decline in exports. However, polyester bottle resin likely will provide enough growth to have a favorable impact on total polyester use of ethylene oxide. If the decline in exports proves larger for the entire year than now forecast, then the bottle resin use will not be big enough to offset total fiber decline. This scenario leads to some industry estimates that 5 billion lb might be all the ethylene oxide produced in 1982.

Antifreeze continues to disappoint producers and forecasters. This year "original fill" demand fell below expectations because of a decline in both size and production of U.S. cars. Replacement antifreeze demand also has not come up to expectations even with increased car life. Another flat year for antifreeze seems likely.

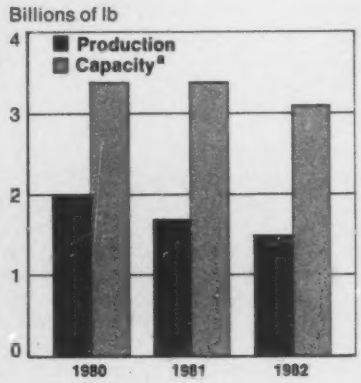
Weak demand for ethylene glycol derivatives carries back to the oxide in downward price pressure. Although ethylene oxide's merchant volume is only roughly 10% of production, competition has forced horrendous (up to one third) discounts this winter and spring from list prices of typically 45 cents per lb. Small increases in real selling prices were attempted as the third quarter opened, but it is too early to tell if the increases will hold.

Key Chemicals

Cyclohexane

- ***Demand way down***
- ***Capacity also down***
- ***Prices fluctuating***

PRODUCTION/CAPACITY



a First quarter.

HOW MADE

Catalytic hydrogenation of benzene; recovery from natural gasoline

MAJOR DERIVATIVES (U.S.)

Adipic acid 60%, caprolactam 30%

MAJOR END USES (U.S.)

Nylon 66, 60%; nylon 6, 30%

FOREIGN TRADE

Exports—may recover after large decline in 1981, imports—negligible

PRICES

$1.64 per gal list; follows benzene price, currently with small discount

COMMERCIAL VALUE

$375 million for production, 1981

Cyclohexane is one of the disaster zones in organic chemicals this year, dealt an exaggerated blow by the recession through crippled end-use markets in housing and clothes. If that weren't enough, the product faces a plant shakeout in the next few years because of demand shifts and a basic change in raw material hydrogen costs.

Cyclohexane production will be down as much in 1982 as it was in 1981. More than 600 million lb less product is being produced during these two years as output drops from 1.96 billion lb in 1980 to about 1.5 billion lb this year.

At the same time, plant capacity is off nearly 300 million lb per year because of an exit by financially troubled Commonwealth Oil in Puerto Rico. At the beginning of 1982, the industry's cyclohexane capacity was about 3.1 billion lb per year. Other production units are shut down temporarily or will be, much as in 1981. Total nameplate capacity will run at less than a 50% rate on average this year.

No additional capacity will come on stream in 1982. Du Pont's planned cyclohexane plant near Corpus Christi, Tex., with unconfirmed capacity of about 300 million lb a year, is due in 1983. This plant, marking Du Pont's entry into this business, will get its raw material hydrogen from the company's adjacent chlor-alkali plant. Such sourcing will give Du Pont, a large cyclohexane user, an advantage that most other producers do not have.

Hydrogen could become a key factor in the future of cyclohexane capacity, according to some industry sources. Generally, a majority of cyclohexane is produced by units adjacent to oil refineries, where catalytic reforming units throw off coproduct hydrogen along with mixed aromatics streams. Refineries' own demand for hydrogen has escalated for hydrotreating heavier, more sour (higher sulfur content) crude oils. The coproduct hydrogen from reforming is considered low cost; thus refiners will use it as fully as possible before building a separate unit to make hydrogen. Hence, if the refiners' cyclohexane business brings a low return on investment because of relatively low prices and operating rates, refiners will tend even more to put hydrogen to other uses and shut down cyclohexane units. As usual, the smaller units, except for those with special sales circumstances, are the prime candidates for closing.

Recovery in demand for cyclohexane depends absolutely on nylon, its overwhelming end use. Nylon has been poor business in the past two years, because of the same depressed housing and clothing markets hurting other parts of the chemical industry. Optimistically, improvement in nylon and, in turn, cyclohexane, might bring a return to 1980 production levels by the end of 1983. After that, there could be slow average growth, possibly 3% annually. Pessimists, however, expect a decade to pass before cyclohexane production again matches the previous high in 1979 of 2.4 billion lb.

That pessimists seem to prevail is evidenced in nylon plant shutdowns, which have started again in recent months. Nylon's major use (nearly 60%) is in carpets, which are suffering from the decline in housing and in replacement of worn items.

Cyclohexane does even worse than nylon and can't grow so much in the future. First, not so much cyclohexane goes into carpets proportionately as does nylon because some nylon is made using phenol raw material. Further, a shift continues toward use of alternative butadiene for making hexamethylenediamine, one component of nylon 66.

Other uses for cyclohexane are small, mostly in solvents. None of these are believed to have much growth in the near future.

Except for exports, cyclohexane is just about a one-outlet material. As goes nylon, so goes cyclohexane. Nylon's prospects are poor to fair depending on the end market. For example, in carpets, nylon continued to grow until the current recession, partly through capture of markets from other fibers. But in tire cord, nylon will continue to slip unless heavy-duty truck and off-the-road tires, a nylon preserve, take significantly larger shares of the total tire cord market.

For the rest of 1982 and 1983, cyclohexane will have to hold onto a weak position at the beginning of a long pipeline to eventual durables consumers, who continue to limit their spending drastically.

IBM Instruments introduces lab computer

Competition among instrument makers to automate analytical laboratories has intensified a bit further with the introduction of a lab computer by IBM Instruments. The firm thus joins Perkin-Elmer and Hewlett-Packard as a supplier of computer systems to run instruments, reduce data, print reports, and keep records (C&EN, March 9, 1981, page 30).

IBM Instruments president Cecil P. Webb says analytical instruments and computers to guide them are a logical market for the parent company. "The global message is that IBM will compete in the eighties in all facets of the growth of the information processing industry. We are a specific example of that message." Webb estimates that worldwide instrument sales totaled more than $2 billion in 1981, growing at 11% per year in constant dollars.

The IBM laboratory computer entry is a compact unit containing a keyboard, multicolor printer/plotter, cathode ray tube (CRT), and 128 kilobytes each of random access memory (RAM) and read-only memory built around a Motorola 68000 microprocessor. A byte is an eight-bit "word" of instruction or information. Chemists would use the RAM memory for programing; the microcomputer itself uses the read-only memory to translate the BASIC language, to diagnose any malfunctions, and generally to run itself.

For now, the only dedicated instrument program IBM furnishes is for gas and liquid chromatography. The IBM machine can run up to four chromatographs. Thus the unit and software seem equivalent to Perkin-Elmer's Sigma 15 "smart" terminal to run chromatographs. The IBM unit's memory can be expanded to an additional 5 megabytes of RAM by insertion of cards containing up to 1 megabyte each. This expanded memory plus possible future programs for various spectrometries might make the IBM microcomputer roughly equivalent to Perkin-Elmer's Model 3600 terminals that run one spectrometer each. Like the 3600, IBM's microcomputer also can serve as host computer to others of its kind for general laboratory management and record keeping.

Motorola has promised improvements in the 68000 central processing unit that may make it competitive with more costly and complex minicomputers. The present information processing rate of 8 MHz will be expanded first to 12 MHz, then to 16 MHz, in the next few years. Amounts of information processed at each step will increase from 16 to 32 bits. Thus the IBM microcomputer eventually could have the capability to manage several dozen instruments as host computer.

IBM Instruments also is involved in a cooperative project with analytical chemistry professor Thomas C. Farrar, of the University of Wisconsin, Madison, to develop programs to let its microcomputer run a Fourier-transform nuclear magnetic resonance spectrometer (FT-NMR). Farrar bought an IBM Instruments FT-NMR spectrometer and microcomputer with a National Science Foundation grant. He hopes to use the microcomputer to increase spectrometer productivity and as a teaching tool. Eventually, Wisconsin investigators will need the spectrometer for only a few minutes per sample, moving the data to the less costly microcomputer for the few tens of minutes needed for further processing. Students also would not need to tie up the spectrometer to learn to run it, as professors simply could furnish raw data to students for processing on a microcomputer.

Since its founding just two years ago, IBM Instruments (headquartered in Danbury, Conn.) has moved with slow deliberation toward its goal of becoming a dominant factor in analytical laboratory instruments and computing. The company has taken each step only when ready, gaining access to strengths it lacks. The firm bought what Cecil Webb describes as a large but noncontrolling interest in the Bruker group of companies—Bruker Physik, of Karlsruhe, West Germany; Bruker-Spectrospin, of Zurich, Switzerland; and Bruker Instruments, of Billerica, Mass. IBM and Bruker collaborated in the design of the FT-NMR, FT infrared, and electron spin resonance spectrometers that Bruker builds for IBM. IBM also has farmed out production of the liquid chromatographs and even the microcomputer it designed and sells. The IBM parent company's manufacturing costs are too high for the few thousand computers IBM Instruments needs yearly, so the subsidiary company contracted with another manufacturer for production. This conservative attitude makes managers reluctant to disclose future plans, which presumably include additions to the instrument line as well as compilation of a library of programs dedicated to each instrument type.

The liquid chromatography program simplifies instrument operation partly by assigning functions to a bank of 57 general-purpose keys on the keyboard. The firm provides an overlay that the user places over these keys. The keys then specify the timing, proportions, and flow rates of up to three solvents in the chromatograph, as well as control experimental conditions and time length.

The company has tried to increase computer serviceability and to lower service costs by including a trouble-shooting program. If the user can identify the defective part, interchangeable parts can be exchanged by courier to avoid costly service calls. IBM Instruments engineers also consult with users by phone, and provide courses in computer repair. As is the case with some of its competitors, IBM Instruments provides a "wet" laboratory and library for prospective customers to prepare samples and continue with their own work while on lengthy visits to IBM to evaluate instruments. The laboratory and library, which has a computer tie-in to several scientific data bases, are also available for cooperative projects between IBM Instruments and other companies.

Steve Stinson, New York

Separation instruments show faster growth . . .

Sales, $ million	1981	1985
Gas chromatography	$318	$ 555
Liquid chromatography	240	515
Othe.	100	120
Subtotal	$658	$1190

. . . but characterization instruments dominate sales

Sales, $ millions	1981	1985
NMR-EPR	$ 140	$ 185
Infrared	118	160
UV/visible	163	220
Atomic absorption	191	280
Nuclear, x-ray	200	260
Mass spectrometry	165	225
Electron microscopy	120	150
Electrochemistry	125	165
Other	175	230
Subtotal	$1397	$1875
TOTAL[a]	$2055	$3063

a Items do not add to total because of rounding. Source: IBM Instruments

Unemployment rises slightly for chemists

Chemists' salaries also are up moderately, but inflation wipes out the gain, annual survey of ACS members indicates

The employment scene for U.S. chemists has darkened slightly but perceptibly this year. Unemployment among chemists who are members of the American Chemical Society had edged up to 1.5% of the total as of last March, after having hovered close to 1% in each of the three preceding years.

Even so, chemists are far less likely to be out of work than is the case with most other segments of the U.S. labor force. The current sharp economic recession has sent unemployment in the U.S. soaring since last summer to the highest levels since just before the U.S. entered World War II. The unemployment rate nationwide was 9.0% of the labor force in March, according to the Bureau of Labor Statistics; since then it has climbed still further, reaching 9.5% in May. The rate for professional and technical workers alone, although considerably lower, also is rising; it was 3.2% this past March, up from 2.7% a year earlier. Although these broader figures dwarf the unemployment rate for chemists found by the latest annual survey of the economic status of ACS members, conducted by the ACS Office of Manpower Studies in March, the rate for chemists has not been higher since 1976.

Salaries earned by chemists, meanwhile, have improved only moderately during the past year, the ACS survey indicates. The median salary for all Ph.D. chemists last March was up just 7% from March 1981's median to $37,500. (The median is that which is exceeded by 50% of the individuals responding to the survey.) Last year, the median salary for Ph.D.s had increased 12% and the year before it had risen 8%.

Ph.D. chemists, nevertheless, fared better during the past year than their colleagues holding lower degrees. For chemists whose highest degree is a B.S., the median salary was up only 4% from a year ago, the smallest year-to-year gain since 1976, to $28,500. They had garnered a 10% increase in 1981 from the previous year. The increase this year for chemists with an M.S. was 5% to $31,600, well below the 15% gain they had enjoyed the year before.

As has been the case in the past, moreover, this year's improvements in chemists' salaries have been eroded by inflation. Consumer prices increased 7% between March 1981 and March 1982. Thus, for Ph.D. chemists, the past year has been a standoff between higher income and a higher cost of living. And both B.S. and M.S. chemists actually lost ground. In constant dollars, the median salary for B.S. holders is 3% lower than in 1981; for chemists with an M.S. it is down 1%.

The further decline of the worth, in terms of purchasing power, of chemists' salaries this year merely extends a trend that has been under way almost unremittingly since 1973, even though the rate of inflation has subsided markedly during the past year. (Consumer prices increased an average of 11.5% in 1979, 13.5% in 1980, and 10.2% last year, but have increased only 6.7% in the past 12 months.) If allowance is made for the impact of inflation, therefore, median salaries for chemists with a B.S. degree are 22% less than nine years ago, and those for chemists with graduate degrees about 17% less.

Chemists also are not keeping up

Unemployment remains relatively low for ACS members across the board . . .

	CHEMISTS									
		By sex		By highest degree			By minority status		Chemical engineers	All ACS members[c]
Employment status[a]	Total	Men	Women	B.S.	M.S.	Ph.D.	Minority[b]	Nonminority		
Employed full time	94.0%	95.2%	86.4%	94.1%	96.2%	93.3%	89.2%	94.5%	94.6%	93.9%
Employed part time	1.4	0.9	4.2	1.8	1.3	1.2	1.1	1.3	1.5	1.4
Postdoctoral or fellowship	2.2	2.0	3.7	0.1	0.3	3.7	7.2	1.8	0.6	1.9
Unemployed										
Seeking employment	1.5	1.3	2.8	2.2	1.4	1.3	1.7	1.5	1.6	1.7
Not seeking employment	0.9	0.6	2.9	1.7	0.8	0.6	0.7	0.9	1.7	1.1

a As of March 1, 1982. b Black, American Indian, Alaskan native, Asian or Pacific, Hispanic, or other. c Includes members whose highest degree and present work are neither in chemistry nor chemical engineering. **Source:** ACS survey

. . . and salary increases are relatively modest

$ Thousands	1982	1981	1980	1979	Change 1981–82
CHEMISTS' MEDIAN SALARIES[a]					
B.S.	$28.5	$27.5	$25.0	$23.5	4%
M.S.	31.6	30.0	26.0	25.0	5
Ph.D.	37.5	35.0	31.2	29.0	7
All chemists	34.7	32.0	28.9	na	8

$ Thousands	1982	1981	1980	1979	Change 1981–82
CHEMICAL ENGINEERS' MEDIAN SALARIES[a]					
B.S.	$40.0	$36.0	$35.0	$31.7	11%
M.S.	42.0	40.0	35.0	31.5	5
Ph.D.	45.0	42.0	38.0	35.0	7
All Ch.E.s	42.0	39.2	36.0	na	7

a As of March 1, 1982. na = not available. **Source:** ACS survey

Experience affects salaries, although more-experienced chemists may not earn more

Years since B.S. degree	Annual salaries of nonacademic chemists ($ thousands)[a]										
	0 to 1	2 to 4	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 or more	Overall
B.S.											
90%	$25.1	$25.9	$32.0	$39.3	$46.7	$49.2	$52.1	$55.9	$72.5	$60.0	$48.0
75%	22.0	23.8	28.5	33.0	39.0	41.0	44.9	47.7	54.7	50.0	37.2
Median	20.0	21.0	25.0	28.0	33.9	35.0	37.0	38.0	43.0	40.9	29.0
25%	18.0	18.3	21.2	24.0	28.0	29.5	30.0	32.2	34.9	34.1	22.5
10%	15.6	16.0	18.3	20.9	25.0	24.0	26.4	25.0	25.9	30.0	18.7
M.S.											
90%	—	28.8	32.5	41.9	49.2	52.0	53.8	62.9	54.5	73.4	50.0
75%	—	26.0	30.0	35.0	40.0	43.1	46.6	49.1	47.5	55.0	41.0
Median	—	24.0	25.5	30.0	33.6	36.2	40.0	40.4	37.8	43.0	33.0
25%	—	20.7	22.0	26.0	29.1	30.0	34.0	34.6	32.0	35.5	26.6
10%	—	18.9	19.0	22.0	25.9	25.3	25.0	30.0	23.7	28.2	22.0
Ph.D.											
90%	—	—	38.0	46.0	52.0	62.4	69.0	70.0	70.0	76.0	60.0
75%	—	—	35.0	40.0	45.0	52.1	57.5	60.0	57.5	63.8	50.0
Median	—	—	32.5	36.0	40.0	45.5	48.0	51.0	49.1	51.0	41.2
25%	—	—	30.0	32.0	35.0	40.0	40.5	44.0	41.0	42.0	34.8
10%	—	—	28.0	29.0	30.3	33.6	35.0	36.0	35.5	36.5	30.0

a As of March 1, 1982. **How to read this table:** Using as an example, B.S. chemists two to four years after having received their B.S. degree, 90% of these chemists have annual salaries of $25,900 or less, 75% have salaries of $23,800 or less, 50% have salaries of $21,000 or less, 25% have salaries of $18,300 or less, and 10% have salaries of $16,000 or less, as of March 1, 1982. **Source:** ACS survey

with blue-collar workers in the chemical industry when it comes to raises. Hourly wages for production workers in chemical plants increased 9% during the 12 months to March 1982, but salaries of chemists in industry were up 8% if they have a Ph.D. and just 4% if their highest degree is either a B.S. or an M.S.

The overall median is only a very rough indication, of course, of how much an individual chemist earns. Salaries vary widely depending on whom chemists work for, the type of work they do, and how long they have been on the job. Because years of experience is such a significant factor in determining salary levels, this year's report on the annual ACS salary survey presents a more detailed breakdown of salary data on the basis of experience than previously (see page 24). In addition, some of the data are adjusted to compensate for differences in length of experience among various groups.

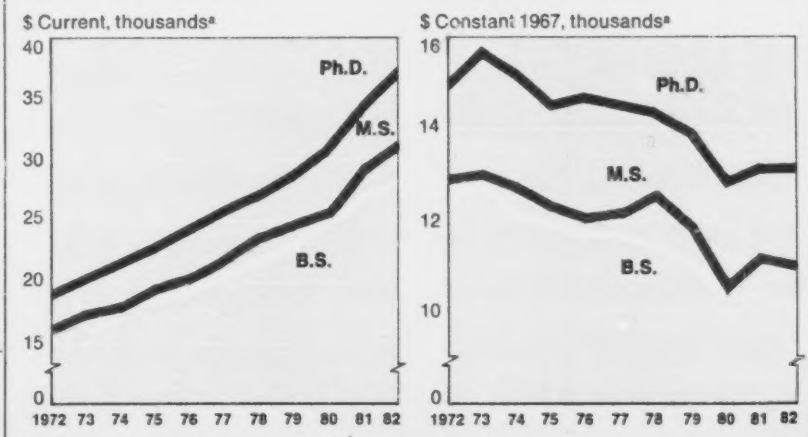
Among the latter are data indicating the difference between salaries earned by men and those earned by women. Men typically have received higher salaries than women, and this continues to be the case this year. For example, among chemists with a B.S. working in industry, median salaries of women are 75% of those of men. For those with an M.S., the women earn 78% of what men earn at the median level. And among Ph.D. chemists, in industry, women earn 80% of what men earn.

These figures do not make allowance, however, for the fact that in the overall sample of industrial chemists, women tend to be younger and hence less experienced than their male counterparts. This would result in a lower median salary for women even if, at any given level of experience, salaries of men and women were equal. Among women chemists in industry, for instance, only 16% received their B.S. degree 20 or more years ago but 48% of the men did so.

If the data are adjusted for this difference in length of experience between the sexes, the gap in salary differentials narrows, although it by no means disappears. On an experience-adjusted basis, women's median salaries are 88% those of men's for industrial chemists with a B.S. degree, 83% for those with an M.S., and 96% for those with a Ph.D. The difference between salaries of men and women is even smaller among chemists who obtained their B.S. degree less than 10 years ago.

Gender is only one factor affecting salaries for industrial chemists. Individuals holding research management or general management positions are likely to earn more than

The increase in chemists' salaries this year... ...was not enough to outpace rising prices



a Median annual salary of chemists as of March of each year. **Source:** ACS survey

Chemists tend to earn more if they are men, working as managers, dealing with polymers

Years since B.S. degree		Median salary of chemists ($ thousands)[a] 0–1	2–4	5–9	10–14	15–19	20–24	25–29	30–34	35–39	>=40	Overall
CHEMISTS EMPLOYED FULL TIME IN INDUSTRY												
Sex												
Men	B.S.	$21.0	$22.0	$26.0	$30.0	$34.6	$36.8	$37.5	$40.0	$45.4	$40.0	$30.6
	M.S.	—	24.2	26.6	30.8	35.0	40.0	42.3	42.0	38.5	43.0	35.0
	Ph.D.	—	—	33.0	36.7	41.5	46.8	50.0	52.5	50.0	54.3	42.8
Women	B.S.	20.5	20.5	25.0	25.0	35.1	32.7	(32.0)	(29.5)	—	—	23.0
	M.S.	—	(24.3)	24.8	27.6	30.5	32.0	(37.5)	(30.5)	—	—	27.3
	Ph.D.	—	—	33.5	33.8	38.0	(35.6)	—	—	—	—	34.4
Work function												
General management	B.S.	—	(24.0)	27.0	34.5	36.9	39.1	39.2	50.0	48.6	(40.0)	40.0
	M.S.	—	—	—	35.0	(41.0)	(40.0)	49.3	49.4	(48.0)	—	43.4
	Ph.D.	—	—	—	44.0	46.0	60.0	55.0	57.5	60.0	(70.0)	50.0
R&D management	B.S.	—	—	25.5	32.5	38.0	43.0	48.0	45.0	53.8	50.0	40.0
	M.S.	—	—	(30.0)	36.5	40.0	46.2	(44.7)	47.0	(40.0)	(53.4)	42.8
	Ph.D.	—	—	34.0	43.0	46.0	53.0	59.0	60.5	51.0	62.9	51.0
Basic research	B.S.	20.4	20.9	24.0	30.0	—	(36.0)	—	(35.3)	—	—	23.0
	M.S.	—	(20.3)	25.0	30.8	(35.2)	(34.0)	—	(42.7)	—	—	29.6
	Ph.D.	—	—	33.0	36.0	41.0	46.2	51.0	49.0	—	(51.8)	38.0
Applied R&D	B.S.	21.5	21.6	24.8	27.7	34.5	36.0	36.9	37.0	39.5	38.5	27.0
	M.S.	—	24.6	25.2	29.5	33.0	33.0	41.0	37.9	36.4	41.0	31.7
	Ph.D.	—	—	32.5	35.0	38.7	43.8	45.6	48.0	45.1	49.0	38.6
Work specialty[b]												
Chemical engineering	B.S.	(25.0)	26.5	30.0	32.0	38.3	41.0	47.0	46.9	55.0	47.0	40.0
	M.S.	—	(29.8)	32.0	34.9	48.7	41.5	47.1	50.5	47.0	51.7	43.5
	Ph.D.	—	—	—	39.1	46.0	55.0	49.7	51.3	56.1	60.0	47.7
Biochemistry	B.S.	—	—	(23.7)	—	—	—	—	—	—	—	22.7
	M.S.	—	—	(21.9)	(32.5)	—	—	—	—	—	—	29.0
	Ph.D.	—	—	(31.5)	35.4	37.5	46.8	(49.0)	(64.5)	—	—	39.5
Agricultural chemistry	B.S.	—	20.2	26.5	27.7	—	(42.5)	—	35.0	(48.3)	—	28.0
	M.S.	—	—	(25.0)	30.3	—	—	(37.4)	(40.0)	—	—	34.0
	Ph.D.	—	—	32.2	36.0	39.4	42.6	43.5	50.5	(50.0)	—	42.0
Analytical chemistry	B.S.	21.0	21.0	25.0	28.0	34.5	33.0	36.8	37.0	41.4	37.0	27.0
	M.S.	—	(23.0)	26.2	30.0	32.5	35.9	39.0	38.2	34.0	(33.5)	30.6
	Ph.D.	—	—	33.0	36.2	39.5	45.8	47.0	52.1	45.5	55.5	38.9
Environmental chemistry	B.S.	—	19.4	27.2	29.5	(38.9)	—	—	38.0	—	—	29.0
	M.S.	—	—	24.5	33.3	(40.6)	—	—	41.0	—	—	35.5
	Ph.D.	—	—	—	(36.0)	(31.5)	48.4	(51.0)	47.0	(50.5)	—	44.0
Organic chemistry	B.S.	21.0	21.6	26.3	34.0	34.5	40.0	40.1	40.0	51.6	41.7	31.0
	M.S.	—	—	30.0	30.0	37.4	40.0	43.4	39.5	48.0	(40.0)	36.4
	Ph.D.	—	—	33.0	36.0	43.5	47.0	52.0	50.8	50.0	51.0	43.1
Inorganic chemistry	B.S.	—	22.0	(25.7)	(30.0)	—	—	—	36.0	—	—	29.0
	M.S.	—	—	(26.6)	—	—	—	—	(47.0)	—	—	38.4
	Ph.D.	—	—	32.3	35.0	38.6	50.0	47.2	—	—	—	37.0
Pharmaceutical chemistry	B.S.	—	20.2	24.5	26.4	(26.9)	36.0	(36.5)	(40.0)	(47.1)	—	25.9
	M.S.	—	(19.4)	24.6	30.2	32.0	(33.5)	—	(44.0)	—	—	31.0
	Ph.D.	—	—	31.4	35.0	42.0	48.7	51.4	59.6	44.0	70.0	42.2
Physical chemistry	B.S.	—	—	—	—	—	—	—	—	—	—	29.0
	M.S.	—	—	—	—	—	—	—	—	—	—	41.0
	Ph.D.	—	—	35.4	36.2	43.2	46.2	50.8	50.0	(50.6)	49.0	43.5
Polymer chemistry	B.S.	(21.6)	22.5	26.0	31.0	35.2	40.0	38.5	42.7	40.0	48.0	33.2
	M.S.	—	(24.8)	29.7	32.0	35.0	33.0	41.1	45.3	(38.0)	(44.0)	34.0
	Ph.D.	—	—	33.0	38.0	42.0	46.8	51.0	54.7	49.5	59.0	43.5
CHEMISTS EMPLOYED FULL TIME IN ACADEMIA (PH.D.s ONLY)												
Ph.D.-granting schools												
Professor		—	—	—	—	$35.0	$37.0	$40.0	$42.9	$42.5	$48.4	$41.0
Associate professor		—	—	—	$30.2	30.0	30.0	29.0	(31.5)	—	(27.5)	30.0
Assistant professor		—	—	$21.0	23.0	23.0	30.6	—	—	—	—	23.0
Non-Ph.D.-granting schools												
Professor		—	—	—	—	28.2	29.0	30.4	30.0	30.0	32.5	29.7
Associate professor		—	—	—	22.5	23.0	24.0	26.5	—	—	—	24.0
Assistant professor		—	—	18.0	19.5	19.3	(21.5)	—	—	—	—	19.2

a As of March 1, 1982. b Refers to current work, not field in which degree was obtained. **Note:** Where no salary data are shown, sample is too small to provide meaningful figure; data in parentheses are from relatively small samples as well and should be treated with caution. **Source:** ACS survey

Salary advantage of men compared to women tends to be least among Ph.D.s

Mean salary, $ thousands[a]	B.S. All chemists	B.S. Men	B.S. Women	B.S. Women as % of men	M.S. All chemists	M.S. Men	M.S. Women	M.S. Women as % of men	Ph.D. All chemists	Ph.D. Men	Ph.D. Women	Ph.D. Women as % of men
EMPLOYER:												
Private industry	$32.2	$32.6	$28.7	88%	$36.2	$36.8	$30.4	83%	$46.1	$46.3	$44.2	96%
College/university	30.1	30.7	27.1	88	33.7	34.7	25.0	72	40.8	41.6	37.0	89
Government	26.8	27.4	24.6	90	31.3	33.0	25.7	78	39.8	39.9	38.6	97
Other nonacademic	24.1	24.7	20.3	82	23.5	24.9	19.4	78	31.1	31.5	26.0	83

a As of March 1, 1982: to facilitate comparison, salaries are adjusted for differences in the average experience for each group. **Source:** ACS survey

those directly involved with doing research and development. And although most chemists in industry have few if any subordinates—nearly 30% have nobody working for them and another 30% supervise only one or two other people—the relatively few who are responsible for a large number of other workers are compensated duly for that responsibility. The median salary for chemists with about 20 or more subordinates—who represent about 10% of all industrial chemists—is more than 50% higher than that for chemists who supervise nobody at all. And the median for those with 50 or more subordinates—less than 4% of the total—is double that for chemists with none.

Chemists' salaries also vary appreciably from industry to industry. As in the past, salaries tend to be highest for those working in the petroleum industry, which employs 6% of all chemists in industry. The chemical industry itself—where more than a third of industrial chemists work—ranks second in salary levels, followed by the pharmaceutical industry. Differences are relatively slight, however, for the 42% of chemists who have jobs in industries other than these three.

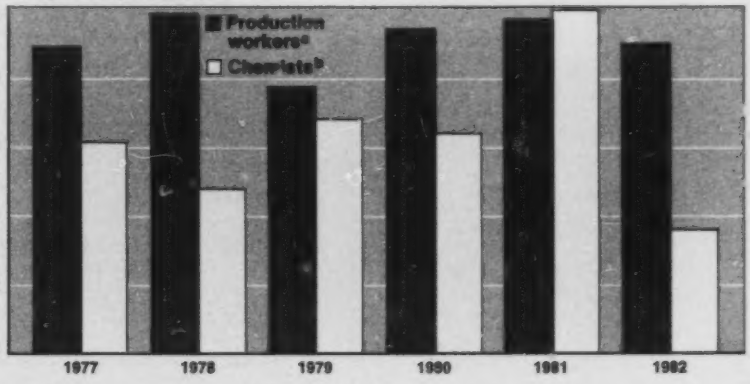
As in the past, as well, chemical engineers responding to the ACS survey have appreciably higher salaries than do chemists. The median for engineers is 40% higher for individuals whose highest degree is a B.S. and

As number of subordinates increases, so do salaries

Number of subordinates	Median annual salaries,[a] chemists in private industry ($ thousands): All chemists	B.S.	M.S.	Ph.D.
ALL SUBORDINATES				
0	$30.0	$24.5	$29.4	$37.5
1–2	35.5	29.4	32.9	38.0
3–7	38.0	31.1	35.5	42.0
8–12	44.0	36.2	36.2	48.0
13–17	48.0	43.0	43.5	52.0
18–22	48.0	37.2	40.0	50.0
23–32	51.2	43.5	48.7	55.0
33–47	59.0	50.0	50.0	63.0
48–67	60.0	51.2	45.5	63.7
68–99	64.6	53.0	57.0	70.0
100 or more	70.0	65.5	52.0	74.4
PROFESSIONALS AND TECHNICIANS ONLY				
0	$30.0	$25.0	$30.0	$37.9
1–2	35.5	29.0	32.6	38.1
3–7	38.5	32.0	36.0	43.0
8–12	45.0	39.0	37.5	48.0
13–17	49.2	43.0	42.3	53.2
18–22	48.0	37.0	44.0	51.1
23–32	53.8	42.2	48.3	56.7
33–47	61.0	52.0	51.2	63.5
48–67	62.0	55.9	56.5	65.0
68–99	70.0	—	69.6	72.0
100 or more	75.0	73.5	—	75.0

a As of March 1. **Source:** ACS survey

Plant workers' wages outpace chemists' salaries



a Average hourly earnings in chemicals and allied products industry. b With B.S. degree.
Sources: Bureau of Labor Statistics, ACS survey

Oil industry pays highest salaries for chemists

Industry	% of industrial chemists: All chemists	B.S.	M.S.	Ph.D.	Mean salary ($ thousands)[a]: All chemists	B.S.	M.S.	Ph.D.
Chemical	35%	31%	30%	40%	$39.7	$32.8	$37.0	$45.5
Pharmaceutical	17	14	20	17	38.9	31.2	35.3	45.2
Petroleum	6	5	4	8	44.0	35.3	40.7	49.2
Coatings	5	7	5	3	36.5	32.3	34.9	42.4
Food	4	5	5	3	36.0	31.1	33.1	42.4
Metals and minerals	3	4	3	2	35.8	30.5	34.1	44.3
Rubber	2	4	3	1	36.3	33.6	32.4	41.4
Paper	1	1	1	2	38.3	30.7	36.7	40.7
Other manufacturing	20	21	22	19	37.7	31.4	36.5	43.8
Nonmanufacturing	6	8	7	5	35.2	28.8	31.8	43.3

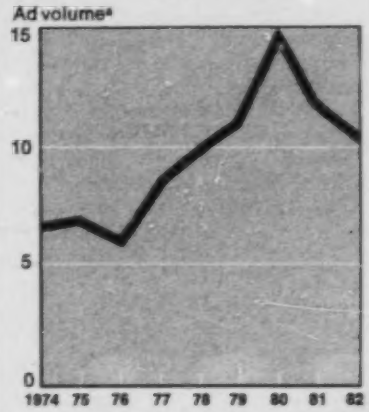
a As of March 1, 1982; to facilitate comparison, salaries are adjusted for differences in the average experience for each group. **Source:** ACS survey

Unemployment among chemists highest since mid-1970s

Employment status[a]	1982	1981	1980	1979	1978	1977	1976	1975	1974
Employed full time	94.9%	95.6%	95.9%	95.0%	95.7%	95.4%	94.7%	95.0%	95.1%
Employed part time	1.4	1.1	1.0	2.0	2.0	1.1	1.3	1.3	1.0
Postdoctoral or fellowship	2.2	2.2	2.2	1.9	1.9	2.1	2.2	2.0	2.5
Unemployed	1.5	1.1	0.9	1.1	1.4	1.5	1.9	1.6	1.4

a As of March 1; excludes unemployed chemists not seeking employment. Source: ACS survey

Help-wanted ads drop to lowest level since 1978



a Volume of help-wanted advertising (in thousands of column inches) in C&EN for the 12 months ending with May of each year.

Age generally a small factor in unemployment

Age	% in category	% unemployed[a]
20–24	2%	2.8%
25–29	11	1.3
30–34	15	1.5
35–39	16	1.8
40–44	15	1.5
45–49	11	1.3
50–54	11	1.7
55–59	10	1.3
60–64	7	1.8
65 and over	2	3.0

a As of March 1, 1982; excludes unemployed chemists not seeking employment. Source: ACS survey

Joblessness varies with what a chemist does

	% in category	% unemployed[a]
MOST RECENT EMPLOYER		
Industry	61%	1.6%
College/university	24	1.3
Government	10	0.8
Other	6	2.6
MOST RECENT WORK FUNCTION		
R&D	38%	1.5%
Teaching	24	1.3
Management[b]	18	1.3
Marketing, production	12	2.2
Other	9	2.1
MOST RECENT WORK SPECIALTY		
Analytical	20%	1.9%
Organic	17	1.1
Polymer	12	1.3
Pharmaceutical	9	1.9
Biochemistry	8	1.6
Physical	7	1.6
Environmental	6	3.0
Inorganic	6	0.7
Agricultural	4	2.0
Other	10	1.1

a As of March 1, 1982; excludes unemployed chemists not seeking employment. b Includes R&D management. Source: ACS survey

20% higher for those who have earned a Ph.D. The salary data for chemists and engineers are not really comparable, however. The engineer respondents tend to be older and more experienced than is the case with the chemists surveyed, for one thing. And engineers account for only a small (9%) part of the overall survey sample, as well as a part that is not representative of chemical engineers as a whole. A disproportionate number of them, for instance, have graduate degrees; 38% of the ACS respondents have a Ph.D., compared to only 16% of the respondents to a similar survey of its members made last year by the American Institute of Chemical Engineers. AIChE members had a median salary of $34,000 in 1981, compared to $39,200 for ACS members who are chemical engineers.

As has been typical in the past, women chemists are more likely to be looking for jobs than are men; 2.8% of the women surveyed were jobless but seeking work last March, up from 2.4% a year earlier; 1.3% of the men were similarly unemployed, up from 0.9% in 1981. (Women also are more likely to be doing postdoctoral work, working part time, or to be out of the job market entirely.)

As in the past, too, chemists whose highest degree is a B.S. are more likely to be looking for a position (2.2%, up from 1.6% in 1981) than is the case for Ph.D. chemists (1.3%, up from 0.8% last year). The greater proportion of unemployed among women and among chemists with no more than a B.S. degree are to some extent interrelated, because among the men in the survey sample only 23% do not have a graduate degree and 60% hold a Ph.D. but among the women 40% have no degree above a B.S. and only 36% have a Ph.D.

It is likely that the employment situation for chemists has darkened further since the ACS survey was completed three months ago. At least that is what is strongly suggested by the volume of classified employment advertising appearing in C&EN in recent months. More advertising of jobs available in chemistry is published by C&EN than by any other U.S. magazine, and the total amount of this advertising in past years has tended to have an inverse relationship to unemployment among chemists.

The volume of such advertising peaked about two years ago and has been dropping erratically since then. In recent weeks, employment ad volume in C&EN had dwindled to only about half what it was just six months ago. It has not been so low as it is at present in nearly a decade.

Most of the data reported here on the employment status and salaries in the chemical profession are drawn from more than 12,000 responses to a survey of ACS members made this past March by the Office of Manpower Studies of the ACS Department of Professional Relations & Manpower Studies. The survey was conducted only among members who are 70 or younger, have a mailing address in the U.S., and are neither student nor emeritus members.

Of the total sample, 84% are chemists, 9% chemical engineers, and 7% do not consider themselves as currently in the chemical profession. Among chemists, 13% are women. A Ph.D. degree is held by 58% of the chemists; 17% have an M.S.; 25% have no more than a B.S.

The ACS Office of Manpower Studies published last month a detailed compilation of data on salaries and employment status based on results from its 1982 survey of ACS members. The full report, "Salaries 1982," can be ordered from the Distribution Office, American Chemical Society, 1155—16th St., N.W., Washington, D.C. 20036. The price of the report this year is $45 a copy. □

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New drugs for combating heart disease Page 26

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Chemical & Engineering NEWS

Cover: Heart patient in Finland has electrocardiogram taken during study of effectiveness of gemfibrozil in lowering lipid levels in the blood. Drug is marketed as Lopid by Parke-Davis, division of Warner-Lambert

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Employee relocation policies expanding

Economic factors are forcing chemical firms to sweeten employee job transfers with mortgage help, relocation assistance, and other aid

Patricia L. Layman
C&EN, New York

Nobody has ever argued that the chemical industry is like the Navy: Join up and see the world. But it always has involved a certain amount of transferring around—from plant to plant, or sales office to sales office—a factor that for a long time was understood and accepted by company and employee alike. The past 10 years, however, have brought some significant changes both to the economics of corporate relocation policies, and to the society that accepts—or increasingly declines—transfers.

Merrill Lynch Relocation Management, one of the major third-party relocation companies, sums up what is happening to some extent in the introduction to its 10th annual study of employee relocation policies of major U.S. corporations. "In the 10 years since this study was first conducted," it says, "significant changes in corporate relocation policies have taken place. This has been due in part to rapidly changing economic conditions."

For example, when Merrill Lynch ran its first study in 1972, inflation was a modest 3% per year, interest rates on home mortgages were only about 6 or 7%, and the average price of a new home was less than $28,000.

Since then, the changing economic scene—most important, the skyrocketing of interest rates—has changed what used to be a fairly calm situation for a company's relocation specialists. Companies have had to scramble to make a job transfer an attractive enough deal for employees to accept. One of the major incentives adopted has been a mortgage-interest differential allowance program. Merrill Lynch, for one, didn't even ask about such programs until 1974, when only 8% of the firms surveyed said they had one. But by 1981, 70% of all firms surveyed had adopted such a program. The figure is even higher in the chemical and plastics industry: Of the 39 companies in that industry that were surveyed, 85% had a mortgage-interest differential allowance.

Similarly, the chemical and plastics industry, on the average, tended to be more generous than business in general in picking up home-sales expenses such as mortgage prepayment penalties, maintenance and repair costs, and realtors' fees; in picking up expenses associated with buying new homes; in reimbursing renters' expenses; and in providing temporary living-arrangement allowances.

But all that comes as no surprise to many relocation specialists. For example, according to H. Cris Collie, executive director of the Washington, D.C.-based Employee Relocation Council, "Chemical companies are among the most enlightened of industries. They have more experience with relocation, and they are in a highly competitive environment, both for new employees and for old ones."

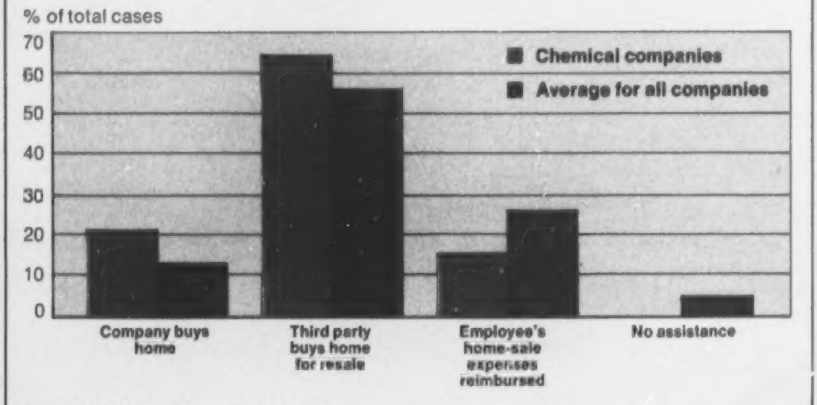
Pearl Meyer, compensation specialist with executive recruiters Handy Associates in New York City, would agree with that. "I would categorize the chemical industry as stable to progressive," she says. "Chemical companies generally are not in the forefront of innovations with their programs, but they are in the luxurious position of not having to be: They can observe how the new ideas are working out in other industries and then take what works well. They are not innovators, but they are very fine implementers."

Corporate relocation specialists say that the economy is forcing them to re-examine their policies, upgrading and expanding them. That helps relieve the financial burden from the employee—only to shift it to the company, which can wind up facing an average cost of $30,000 to $35,000 per move, according to Collie.

Last year, the average number of employees per company transferred in the chemical and plastics industry was 146, down 10% from 1980, according to Merrill Lynch. On the other hand, 1982 probably will see an increase—if only because Union Carbide's move from New York City to Danbury, Conn., completed this spring, probably will skew the results somewhat.

A slowed-down economy, however, has double-edged consequences: It encourages companies to hold down transfers wherever possible, but it also encourages employees to accept a transfer. That was one conclusion, for example, of a survey released last month by Employee Transfer Corp., a Chicago-based relocation company. ETC surveyed employees who were

Chemical companies give better home-sale assistance



Source: Merrill Lynch Relocation Management

relocated in 1981 and determined that 84.9% of them would be willing to relocate again. That figure portends a reversal of the four-year downturn in willingness to move that started with 84.4% in 1977 and dropped to 76.3% in 1980.

"Conceivably, the economy is playing a role in inducing more people to transfer as a way to hold onto their jobs," according to ETC officials.

Even without a dampened economy, however, chemical industry relocation specialists say that, contrary to some reports, they are not running into serious problems in inducing employees to accept relocation.

To some extent, they believe, this may reflect the basic nature of the chemical industry: that employees often have to relocate to rise in their company's ranks. Employees understand that, explains one personnel manager, and so they accept the possibility of a relocation when they enter the industry.

But that's not to say that certain kinds of relocations may not be resisted by employees. The Merrill Lynch study, for instance, found that 56% of the 39 chemical and plastics companies surveyed reported that they have had difficulties in getting employees to accept a transfer into an area with a high cost of living. That reason, for one, was cited by Union Carbide for its decision to move its headquarters out of New York City.

Companies also report that employees are asking more questions about the life style aspects of the move—the community, the environment, and so on—rather than just about the monetary aspects. That's a healthier, more realistic situation than blind acceptance of a move, executives say.

When an employee declines a relocation, that also can benefit the company, in terms of preserving continuity within a business unit and strengthening corporate loyalties. That's particularly true, corporate officials believe, as policies change so that an employee can turn down a relocation knowing that it won't finish his or her career on the spot.

The phenomenon of the dual-paycheck family is just starting to be felt in a major way in the chemical industry. In the Merrill Lynch study, for example, 76% of the chemical and plastics companies surveyed did not offer job-finding assistance for working spouses, and only 24% did. Much of that "no assistance" means no hard assistance—actually contacting other companies to find potential openings, or offering the spouse a job with the company itself. More commonly, companies will refer spouses to employment counselors or agencies. And if the spouse also is employed by the company wanting to relocate an employee, it generally will work out a second transfer for the spouse, according to many of the industry's human resource managers.

Collie: chemical companies enlightened

To some extent, it's a matter of the working level of the spouse. Some companies, in fact, draw a distinction between "dual paycheck" family and "dual career" family. The dual paycheck couple, for whom the second check primarily is an extra source of income rather than a professional or career expression, usually is accommodated fairly easily, personnel officials say. It is the dual career couple that can pose problems in a couple's transfer flexibility. Secretarial skills, for example, generally are more easily transferable than those of, say, a product manager or research project leader.

Regardless of that distinction, the phenomenon exists and is growing: Some 24.5 million married women are working or seeking employment, and that number is expected to increase through this decade, with dual earners—as the Bureau of Labor Statistics calls them—becoming by far the rule.

Companies have been making substantial additions to their relocation policies to sweeten the deal for employees, and they are not satisfied with the present status quo. According to the Merrill Lynch study, 28% of the chemical and plastics companies surveyed anticipate making changes in their policies this year, with another 8% undecided. Although the overall business average is 27% of companies that plan to make some changes, to a great extent that depends upon how many people a company transfers; 63% of the companies in the whole study that transfer 500 people or more said they would be making policy changes this year, as did 38 to 39% of the firms that transfer 100 to 499 employees.

The 11 chemical companies planning policy changes cited such changes as developing or increasing a mortgage interest differential allowance (40%), developing or increasing miscellaneous expense allowances (20%), and developing or increasing temporary living allowances and mortgage assistance programs (each 10%). Another 10% are considering covering more employees or new hires.

For new hires, that prospect will be particularly welcome, because the benefits offered them are decidedly less than those for employees. Both

Chemical, plastics firms outpace others in transfers

Number of employees transferred[a]	% of chemicals and plastics firms reporting	% of companies in all business
None	—	1%
1–24	32%	33
25–49	8	16
50–99	16	15
100–249	35	20
250–499	—	8
500 or more	8	6

a Average number of employees transferred per company was 146 for chemicals and plastics, down 10% from 1980, and 140 for all business, up 2% from 1980. **Source:** Merrill Lynch Relocation Management

Expenses to relocate employee top $30,000

Selling the house	$ 11,000
Payment of mortgage interest differential	10,000
Shipping goods to new location	3,000
New-home purchase closing costs	2,500
House-hunting trips	2,000
En route and temporary living expenses	1,000
Miscellaneous allowances[a]	2,500
TOTAL	$ 32,000

a For example, for recutting of drapes, new license fees, etc. Usually one half to one month's salary. **Source:** Employee Relocation Council

Carbide's mammoth task in moving headquarters

If the average chemical company transfers 200 employees each year, then Union Carbide has packed nearly six years of experience into the past two years. It transferred about 97% of its employees from its Manhattan and Tarrytown, N.Y., offices to new corporate headquarters in Danbury, Conn., with the first job moves in July 1980 and the last batch this spring.

For the numbers involved—more than 3000—it was an exercise akin to an army mapping out battle plans. When the new headquarters were first announced in May 1977, Carbide's employee-relations people went to work. First item on the agenda: Decide whether to do the job in-house, or to work with an outside consultant with expertise built up in the field.

"We decided to do the latter," recalls Ernest F. Schulz, manager of the headquarters assistance program at Carbide. Moran, Stahl & Boyer was selected, and it helped prepare and conduct a survey for all employees. As one indication of the potential significance of the move, the department got back close to 90% response.

"That survey told us where our employees were coming from, and what their needs were," says Schulz. "We were able to integrate that into our program." The company published an official booklet on the program that went through two editions, with subsequent revisions later on.

As a Manhattan-based company, Carbide had a substantial proportion of urbanites among its employees. That posed special problems. For example, Schulz says, "We recognized that there was a large number of employees who didn't know how to drive. So we included a driver-training plan," reimbursing tuition for the employee and for one other household member. Additionally, many of the employees had subsidized or rent-controlled housing, or lived with parents—low shelter costs that would be lost. "So we adopted a renter-to-renter program, and piggybacked onto that, a renter-to-home-owner allowance," Schulz says, with rent-increase and home-buying down payment assistance.

Since the relocation benefits were being offered to all salaried employees, from the chairman of the board to the entry-level clerk, the company surmised that in nonprofessional ranks, in particular, there might be little experience with relocation. So Carbide worked with Moran, Stahl & Boyer subsidiary Area Consultants Inc. to counsel employees and spouses on the move.

In general, Carbide provided assistance with the selling of homes, working with a third-party home-buying company, Merrill Lynch Relocation Management. It paid for the costs of selling the house, moving household belongings, including packing and unpacking. It reimbursed fees for the new residence, including realty fees and those for engineers' inspections. It agreed to pay mortgage differentials for five years. And, to round things out, it paid an allowance for miscellaneous expenses, one month's salary up to $3000.

Out of a total of 3200 jobs in the New York area, the company transferred 3100. Two thirds of the employees lived within commuting range of Danbury, but another 1100 actually were relocated. Schulz won't divulge how much the move cost—that's proprietary information, he says. But he notes that because most of the relocations were made over a relatively short geographical distance, and employees were able to plan with flexibility—anytime between May 1978 and May 1984—the average cost was substantially lower than the industry average of $30,000 to $35,000 per employee.

The entire operation, Schulz says, "went extremely well." He admits to a certain amount of prejudice, because he was in charge of developing it and putting it into effect. But, he adds, "The success is obvious from the high retention rate we had." Would he want to do it again? "Sure, anytime," he says airily—and then laughs.

the Merrill Lynch study and one conducted earlier this year by Russell Reynolds Associates, an international executive recruiting firm, have explored some of the differences.

The Russell Reynolds study looked at the obstacles facing a sample of 180 businesses seeking senior executives—defined as those earning $50,000 or more per year. Some 45% of the chief executives polled replied that it was "much more difficult" to induce prospective senior executives to relocate geographically. Another 42% said it was "somewhat more difficult," and only 11% saw no change. High mortgage rates were the major stumbling block. The next most frequently cited obstacle was difficulty in selling a present residence. Despite that, although 61% said that relocation problems had had some effect on recruitment procedures, only 16% of the companies surveyed said they had made a major effort to recruit locally.

To attract potential candidates, Russell Reynolds found, companies often offer such benefits as payment of temporary or duplicate living expenses (81%), payment of home sale expenses (72%), subsidized mortgages (59%), and engagement of a relocation assistance firm (46%).

On a general level, however, benefits such as those for incoming recruits are less common, according to the Merrill Lynch study, than for a company's current employees. In fact, of the 39 chemical companies in the Merrill Lynch study, only 24 said they provide such assistance for new professional hires. Of those 24, 75% reimburse the hires for some or all of the home sale expenses, and only 50% reimburse for the cost of disposing of a rented apartment. Some 96% reimburse the new professional hire for one or more house-hunting trips, for shipment of household goods, and for transportation of the family to a new location. But only 54% offer reimbursement for some or all of the closing costs on new homes.

The picture is somewhat brighter for new college graduate hires; 30 of the 39 chemical companies sampled provide relocation assistance. But that picture is more spotted. Only 90% of the companies, for example, provide one or more house-hunting trips and transportation of the family to a new location; 93% reimburse for shipment of household goods. Only 40% of the companies reimburse the new college-grad hires for any home sale expenses.

In the long run, however, whether companies match for new recruits the relocation benefits they pay for present employees, the trend is clear: With the average cost of a move hovering around $35,000, companies will be making benefits available to fewer people. Re-evaluation of the need to relocate also will reflect the increasingly expensive time an employee being relocated is out of full productivity—at least for several months and possibly for up to a year as the employee is preoccupied with the idea and then the nitty-gritty details of the move, and the emotional highs and lows of post-move transition. Such re-evaluation should be of benefit to both the company and the employee. □